

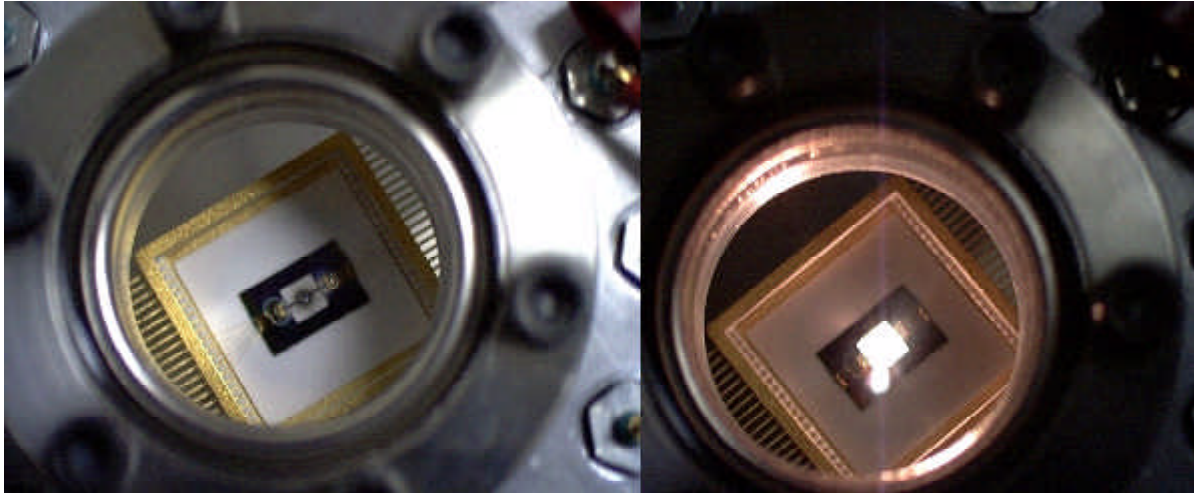
# **Microelectromechanical Systems (MEMS)**

## **Broadband Light Source Developed**

A miniature, low-power broadband light source has been developed for aerospace applications, including calibrating spectrometers and powering miniature optical sensors. The initial motivation for this research was based on flight tests of a Fabry-Perot fiber-optic temperature sensor system used to detect aircraft engine exhaust gas temperature. Although the feasibility of the sensor system was proven, the commercial light source optically powering the device was identified as a critical component requiring improvement. Problems with the light source included a long stabilization time ( $\sim 1$  hr), a large amount of heat generation, and a large input electrical power (6.5 W). Thus, we developed a new light source to enable the use of broadband optical sensors in aerospace applications.

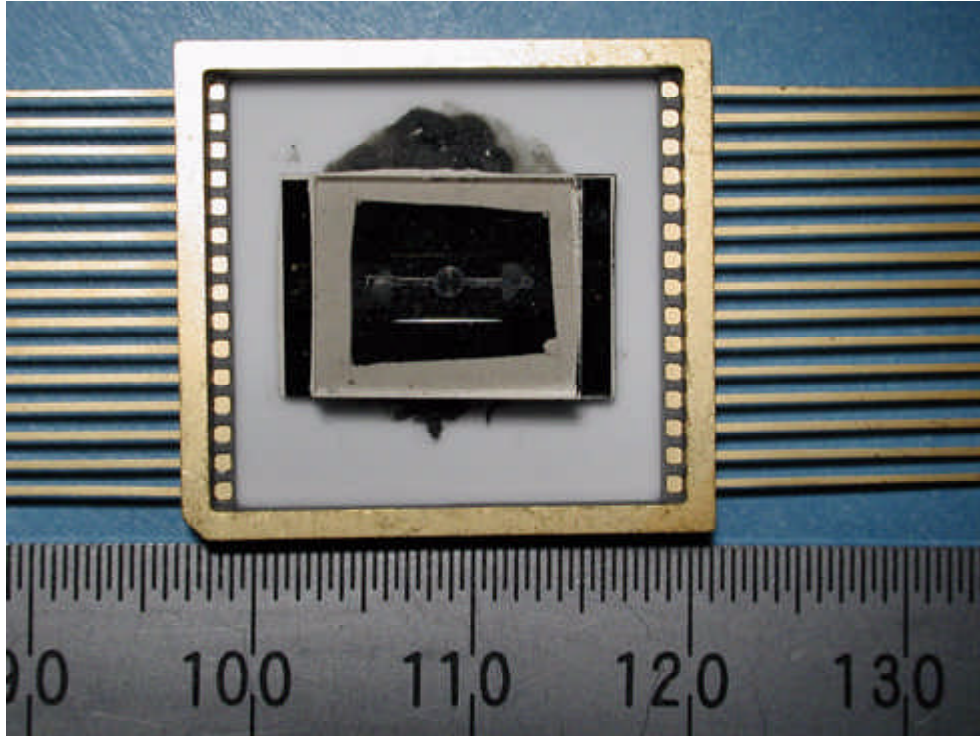
Semiconductor chip-based light sources, such as lasers and light-emitting diodes, have a relatively narrow range of emission wavelengths in comparison to incandescent sources. Incandescent light sources emit broadband radiation from visible to infrared wavelengths; the intensity at each wavelength is determined by the filament temperature and the materials chosen for the filament and the lamp window. However, present commercial incandescent light sources are large in size and inefficient, requiring several watts of electrical power to obtain the desired optical power, and they emit a large percentage of the input power as heat that must be dissipated.

The miniature light source, developed jointly by the NASA Glenn Research Center, the Jet Propulsion Laboratory, and the Lighting Innovations Institute, requires one-fifth the electrical input power of some commercial light sources, while providing similar output light power that is easily coupled to an optical fiber. Furthermore, it is small, rugged, and lightweight. Microfabrication technology was used to reduce the size, weight, power consumption, and potential cost-parameters critical to future aerospace applications. This chip-based light source has the potential for monolithic fabrication with on-chip drive electronics. Other uses for these light sources are in systems for vehicle navigation, remote sensing applications such as monitoring bridges for stress, calibration sources for spectrometers, light sources for space sensors, display lighting, addressable arrays, and industrial plant monitoring.



*Prototype filament in vacuum chamber. Left: Device turned off. Right: Device turned on.*  
 Long description of figure 1 Through a magnifying glass, the coiled filament is shown both turned off and turned on in this photograph. When the filament is turned on, it glows brightly with white light.

Two methods for filament fabrication are being developed: wet-chemical etching and laser ablation. Both yield a 25- $\mu\text{m}$ -thick tungsten spiral filament. The proof-of-concept filament shown in the preceding photographs was fabricated with the wet etch method. Then it was tested by heating it in a vacuum chamber using about 1.25 W of electrical power; it generated bright, blackbody radiation at approximately 2650 K (see the preceding photographs). The filament was packaged in Glenn's clean-room facilities (see the following photograph). This design uses three chips vacuum-sealed with glass tape. The bottom chip consists of a reflective film deposited on silicon, the middle chip contains a tungsten filament bonded to silicon, and the top layer is a transparent window. Lifetime testing on the package will begin shortly. The emitted optical power is expected to be approximately 1.0 W with the spectral peak at 1.1  $\mu\text{m}$ .



*Prototype packaged device.*

Long description of figure 2 The filament is the spiral-shaped object enclosed by top and bottom wafer in this photograph. The top window is about 10 by 5 mm, and the bonded chips are set in a multi-pin mounting package.

**Find out more about the MEMS white light source**

**<http://www.grc.nasa.gov/WWW/OptInstr/tuma/MEMSwhite.html>.**

**Glenn contact:** Dr. Margaret Tuma, 216-433-8665, Margaret.L.Tuma-1@nasa.gov

**Author:** Dr. Margaret L. Tuma

**Headquarters program office:** OSS

**Programs/Projects:** NEPP